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ABSTRACT

The Community School District Six Laptop Project (New York, NY) was created in order to increase access to technology for families in a low-income area with a large immigrant population. As part of the project, the sixth-grade students in this study received IBM ThinkPads. Trends that appear in the literature on integrating technology into the curriculum are first discussed. Changes that occurred with the introduction of the laptops into this particular sixth-grade classroom are then described, followed by a case study of a unit on ancient Egypt taught in both laptop and non-laptop settings. The "Create-a-Character" project required students to work in two groups: the first group did not have access to any computer technology, while the second had constant access to their laptops. Findings from both groups are discussed in terms of collaboration, the writing process, research skills and critical evaluation of information, and presentations. Results of the study suggest that laptops enable change in the management of the classroom and in the design of instructional activities and assignments. (Contains 39 references.) (AEF)

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Transforming the Daily Life of the Classroom:

The District Six Laptop Project

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One Teacher's Experience: New Tools, New Practices

In the fall of 1997, my sixth graders and I received brand-new IBM ThinkPads as part of the Community School District Six Laptop Project. My students were thrilled, and on a personal level, I was excited as well. As an educator, however, I had some reservations. On one hand, I looked forward to the challenge of learning to use this new tool to develop my students' academic and personal capacities. I regarded technological knowledge as crucial to my students' future success, and I had great faith in the ability of technology to organize, deepen, and enrich their learning. On the other hand, I was anxious to maintain and extend the types of learning experiences I had found successful in the past. I had spent significant amounts of time studying, implementing, and adapting such progressive approaches as reading and writing workshops (Atwell, 1987; Calkins, 1986), authentic student-centered discussions (Daniels, 1994; Beck, McKeown, Hamilton, & Kucan, 1997).), and interdisciplinary curriculum projects (Gardner, 1991; Moore, D., Moore, S., Cunningham, P., and Cunningham, J., 1994). I didn't want to abandon these efforts in a mad rush for the "computer technology bandwagon."

The District Six Laptop Project was founded with the philosophy of using technology as a tool to develop student understanding of the curriculum, rather than technology as a vehicle for drill or as a curriculum area in and of itself. Like paper and pencils, markers and glue, books and magazines, laptop computers are merely tools that students and teachers can use to develop and share their understanding of the world. At the outset of the program, I certainly didn't expect that the addition of a mere tool would change my classroom practice significantly. I imagined that daily life in my classroom would continue much the same, the only difference being that when appropriate, my students would use computers to replace or supplement more traditional classroom tools.

However, laptops possess specific characteristics, some of which overlap with more traditional tools, but many of which afford new functions in the classroom. Word processing software facilitates the feedback and revision necessary to the writing process. Spreadsheets and databases allow students to categorize, manipulate, and represent data in diverse and flexible ways. Presentation software allows students to represent information with a rich variety of media – text, sound, graphics, color, and animation. As my students and I became more proficient with the laptops, I found myself changing my instruction in ways that utilized the machines' unique capabilities.

Changing the nature of the tools available to me as a teacher ended up changing the nature of daily life in my classroom. Specifically,

1) I created new procedures for several aspects of classroom management in order to take advantage of the special capabilities of the laptops.
2) Students began to collaborate spontaneously, because of an authentic desire to share information about different features of the software and the computers themselves.
3) Students were able to organize and revise their work with greater ease.
4) I placed a greater emphasis on research skills and the critical evaluation of information.
5) I assigned student presentation projects with greater frequency.

As a reflective practitioner (Schön, 1983) I consider it important to question and evaluate the nature of the changes in my teaching. Why did these changes occur? What specific features of the laptops contributed to these changes? How did these changes in the daily life of the classroom impact student learning and growth?

Review of the Literature

Teachers' pre-existing beliefs and practices strongly influence the manner in which they adopt any classroom innovation. Recent studies, focusing specifically on the integration of technology into the classroom, suggest that technology in and of itself does not cause changes in the teaching and learning process: teachers can simply avoid using it, or they can use it for

purposes that merely replicate their pencil and paper practices (McMillan & Honey, 1993; Means, 1995; Roblyer, 1996; Schofield, 1995; Rubin & Bruce, 1986). Miller and Olson (1994) examine the practice of a teacher who claims that technology has "completely changed" her teaching, only to find that she uses computers for essentially the same functions as pencil and paper – failing to take advantage of the unique features of the software, such as revising, editing, and publishing functions.

While increased access to computer technology may not directly cause teachers to change their instruction, evidence indicates that computers may foster a certain teaching style. This phenomenon is most apparent in studies comparing the behavior of the same teachers with and without access to technology. When studying the impact of a computerized geometry tutor on secondary mathematics classrooms, Schofield (1995) looked at the behavior of teachers who taught both computer and non-computer classes. With their non-computer classes, the teachers relied primarily on whole-group lectures and working problems at the board; but with their computer classes, they circulated among the students, providing individualized assistance and "coaching" as needed. When studying the impact of technology on the teaching of various subjects at two Canadian secondary schools, Goodson and Mangan (1995) found that teachers of subject areas that had previously relied upon student-centered, small-group strategies, such as art or family studies, were able to incorporate computers into their instruction more extensively than others. However, regardless of subject area, increasing the number of available computers increased the proportion of classroom time devoted to small group activities and decreased the proportion devoted to teacher-initiated activities and teacher questioning.

Without discounting the effect of teachers' pedagogical beliefs and practices on their use of technology, certain trends appear consistently in the literature on integrating technology into the curriculum.

1) Technology increases student engagement and motivation.
2) Using technology prompts teachers to move towards a more facilitative role, fostering more individualized and independent learning.
3) Extensive computer use leads to higher levels of student collaboration.
4) Greater access to technology leads teachers to assign more project-based work, particularly research projects.
5) Increased technology use leads to higher quality student work.

I will briefly outline the nature of these changes as described in the literature, taking special care to include information on laptop classrooms whenever such information is available.

1) Technology increases student engagement and motivation.

Numerous studies report increased student engagement and motivation as the most common effect of technology use in the classroom (McDonald & Ingvarson, 1997; McMillan & Honey, 1993; Means, 1995; Rockman, 1997; Rockman, 1998; Schofield, 1995). Teachers and researchers suggest various reasons for this pervasive phenomenon. The visual, auditory, and kinesthetic experiences provided by modern computer interfaces may provide a more engaging learning environment for students with different learning styles (Means, 1995, Rockman, 1997). Students also appear to enjoy the immediate feedback and sense of control involved with manipulating the computer interface (Means, 1995, Schofield, 1995). The ability to control one's learning environment, particularly an environment unfamiliar to many adults, is likely to appeal strongly to adolescent students as they strive to develop a sense of personal efficacy and identity, separate from the adults in their lives (Elkind, 1994; Feldman & Elliot, 1990). While it is possible that some of students' increased engagement stems from the novelty of using computers in school, teacher and student surveys have indicated that students' motivation to

work with computers does not substantially decrease with prolonged access over time (Rockman, 1998).

2) Using technology prompts teachers to move towards a more facilitative role, fostering more individualized and independent learning.

Teachers in technology-rich environments appear to spend less time using whole-class, teacher-directed methods and more time using small-group and individualized strategies (Goodson & Mangan, 1995; McDonald & Ingvarson, 1997; McMillan & Honey, 1993; Means, 1995; Rockman, 1997; Rockman, 1998; Schofield, 1995). When students are working on computers, teachers tend to move among students or groups of students, facilitating the students' work by offering individualized help and encouragement. This result appears to hold true in studies of several different configurations of computer use – laboratory settings, classroom-based cluster settings, and laptop classrooms. However, the more concentrated the technology, the stronger the effect on instructional style. Goodson and Mangan (1995) found the proportion of time devoted to teacher-led activities decreased as the setting became more computer intensive. The percentage of instructional time spent on teacher-led activities decreased from a high of nearly 40% of instructional time in regular classrooms, to 15-20% of instructional time in classrooms with clusters of 5-7 computers, to a low of about 10% of instructional time in computer labs. However, teachers who shift to a more facilitative instructional style when using computers do not necessarily maintain this style when computers are not in use. Schofield (1995) found that teachers piloting a computerized geometry tutor reverted back to their traditional teaching methods when not in the computer lab. Therefore, the shift to a more facilitative teaching style is likely to be stronger and more pervasive in laptop classrooms, where all students and teachers have constant access to the technology.

One of the primary reasons for the shift towards a more facilitative teaching style may be the fact that in computer-based classrooms, teachers cannot be the sole source of information. Teachers often must learn the technology along with their students, and so they may adopt a more collaborative role by necessity. They may find themselves turning to their students for help in solving technological problems or manipulating software, a phenomenon observed almost universally (McMillan & Honey, 1993; Means, 1995; Rockman, 1997; Rockman, 1998; Schofield, 1995).

In the traditional classroom, the teacher controls the flow of information. Not only is the teacher presumably the expert in the subject area, but he or she is already familiar with the texts and other materials used in class. In computer-based classrooms, by contrast, students often have access to multiple sources of information, such as educational software, CD-ROMs and the Internet. Teachers cannot possibly be familiar with all of their students' sources of information. Knowing that students are able to access information that they themselves might not have, teachers appear more willing to act as guides to their students in a quest to acquire information or solve problems (McDonald & Ingvarson, 1997; McMillan & Honey, 1993; Means, 1995; Rockman, 1997; Rockman, 1998; Schofield, 1995).

The move to a more facilitative and individualized teaching style may also be related to students' engagement with technology. Means (1995) reports that as teachers witness their students displaying more excitement and initiative in their own learning, they adjust their instructional strategies to give students more responsibility. Teachers may find it easier to manage a student-centered environment when students are using technology. As students are absorbed with their computers, teachers are free to consult with students who need additional help, and advanced students are free to move ahead at their own pace. In technology-intensive

environments, teachers have been observed to spend significantly more time consulting with individual students than in other classrooms (McDonald & Ingvarson, 1997; Schofield, 1995; Rockman, 1997; Rockman, 1998). In the words of a student in the Schofield study, "[The teacher] doesn't teach us anymore. He just helps us." (p.30)

3) Extensive computer use leads to higher levels of student collaboration.

Numerous research studies demonstrate that students using computers engage in collaborative activities more frequently than their peers in non-computer classrooms (Gallini, 1997; Goodson & Mangan, 1995; McDonald & Ingvarson, 1997; McMillan & Honey, 1993; Means, 1995; Rockman, 1997; Rockman, 1998; Schofield, 1995). Increased student collaboration seems to occur in two forms: teachers' increased use of small group instruction and students' spontaneous sharing of knowledge about their computers.

Introducing technology into the classroom appears to increase significantly the percentage of time spent in small group work (Goodson & Mangan, 1995; McDonald & Ingvarson, 1997; Means, 1995; McMillan & Honey, 1993; Rockman, 1997; Rockman, 1998). Goodson and Mangan (1995) found that in regular classrooms, small group activities accounted for approximately 50% of instructional time; in classrooms with clusters of 5-7 computers, approximately 75% of instructional time; and in a laboratory setting, approximately 90% of instructional time. In classrooms involved in Microsoft's Anytime, Anywhere Learning pilot program, laptop students spent more than twice as much time engaged in group work as their counterparts in non-laptop classes (Rockman, 1998).

Why this shift towards small group work? Goodson and Mangan (1995) point out that software is generally designed to be operated by an individual or a small group, and thus can be used more effectively by small groups than by the whole class. This shift may also reflect a

conscious decision by teachers to adjust their instructional strategies to take advantage of the ease of organizing group projects on the computers (McDonald & Ingvarson, 1997; McMillan & Honey, 1993; Rockman, 1997; Rockman, 1998).

As any teacher knows, merely assigning group work doesn't guarantee a culture of student collaboration. However, teachers in computer-intensive classrooms consistently observe students sharing their knowledge about different software features and troubleshooting strategies (McDonald & Ingvarson, 1997; McMillan & Honey, 1993; Means, 1995; Rockman, 1997). Many of these teachers report that spontaneous student collaboration in computer use carries over to other aspects of classroom life, significantly changing the culture of the classroom. Laptop students, who have access to their computers during their free time, are much more likely to experiment with the software, discover interesting capabilities, and share these discoveries with their peers (Rockman, 1998), and thus the increase in collaboration is likely to be even more pronounced in laptop classrooms.

4) Greater access to technology leads teachers to assign more project-based work, particularly research projects.

Teachers involved in technology integration report that computers help students engage successfully in complex tasks, such as project-based work (Means, 1995); and studies of laptop classrooms in particular appear to indicate a strong increase in project-based instruction (McDonald & Ingvarson, 1997; Means, 1995; Rockman, 1997; Rockman, 1998; McMillan & Honey, 1993).

At least two factors underlie this increase. First, multimedia software allows students to organize and connect isolated tasks into large-scale projects. Students can easily integrate text, spreadsheets, graphs and charts, drawings, sounds, and photographs into one presentation.

Second, laptops generally afford students access to a broader range of information, whether through the Internet or through educational software and CD-ROMs. Both the increased access to research material and the availability of software to present that material are conditions that lead teachers to rely more on project-based instruction.

Teachers also report that because their students have greater access to information, they have begun to teach the research process differently. Instead of emphasizing acquisition of facts and information, they emphasize skills such as framing research questions and evaluating sources; these skills help students manage information more effectively (Rockman, 1998)

Although project-based instruction may be part of any technology-based classroom, it is perhaps not surprising that evidence of this approach shows up most strongly in laptop classes. In-depth projects are likely to become exceedingly time-intensive, and teachers without continual access to computers may worry about conserving their valuable computer time. Since laptop students have access to their computers on a continual basis, their teachers may be more willing to assign projects on the computer.

5) Increased technology use leads to higher quality student work.

Teachers in a variety of settings attest to the effectiveness of technology in improving the quality of their students' work (Means, 1995). A substantial body of research now demonstrates the efficacy of word processing tools in supporting students' development as writers (Bangert-Drowns, 1993; Cochran-Smith, Paris & Kahn, 1991; Daiute, 1985; Russell, 1991). Students with access to word processing programs tend to write more, make more substantial revisions of content, and edit more carefully. Because of their constant access to their own computers, laptop students are especially likely to know and utilize advanced features of their word processing program, such as outlining capabilities or commenting features (Rockman, 1998).

However, the capabilities of computers extend far beyond word processing. Not only do computers increase students' access to a wide variety of information sources, but tools such as spreadsheets, databases, and multimedia presentations all help students manipulate and organize their information. Rockman (1998) found that laptop students using the Microsoft Office suite of applications grew in their ability to locate and analyze information, construct an argument, and organize and deliver presentations. Teachers described these changes in anecdotal reports; and in problem-solving simulations, laptop students significantly outperformed non-laptop students in these dimensions.

Methodology

Seventy years ago, Dewey (1929) argued that curriculum development would be ineffective without the involvement of those actually involved in teaching. In more recent years, teacher research groups have been used to facilitate the change process in the adoption of new and innovative teaching methods (Holly, 1991). Because the integration of computers into the curriculum has had such a varied success rate, teacher research must play an especially critical role in the area of technology integration. Educators need as much information as possible from the practitioner's viewpoint in order to be able to make intelligent decisions about new and effective ways to incorporate technology in the curriculum. The qualitative observations and analyses of individual teachers can offer the type of rich, detailed information that may lead to the framing of new research questions and the development of new theories (Patton, 1987).

Holly (1991) describes a "research in/of action" approach to teacher research, in which practitioners evaluate actions that have already been performed. The present research will use this approach to analyze the changes that occurred in the daily life and culture of a classroom with the introduction of laptop computers for every student. First, a conceptual overview is

provided, outlining the major trends observed in my classroom. Second, these trends are illustrated through a case study of a social studies curriculum project. This project was implemented both during the 1995-96 school year with a non-laptop class and two years later, during the 1997-1998 school year, with a laptop class. The two implementations are compared and contrasted to discern ways in which the introduction of a new tool changed the nature of the project. For both sets of observations, multiple sources of data were used, including personal and professional journals, teacher plan books; student work; and other classroom artifacts, such as assignment sheets and work folders.

Setting

The Community School District Six Laptop Project was created in order to increase access to technology for families in a low-income area with a large immigrant population. In the district as a whole, 92% of the students live below the federal poverty level, and 89% of the students are native speakers of languages other than English (predominantly Spanish). In my particular school setting, 15% of the students have arrived in the United States within the last three years. A full 40% of the students in the school are classified as limited English proficient, although many of them have opted out of the bilingual education program and into regular classrooms.

The students in this study received IBM ThinkPad 380s equipped with the Microsoft Office 97 suite of programs, including Word, Excel, PowerPoint, and Access. The students received their laptops at a rollout session in early October, and after that date, they were allowed to use their computers both at school and at home. However, because students could not take their laptops home unless accompanied by an adult (for safety reasons), some of them chose to

leave their laptops in school.* In this case, students were able to come to the classroom at lunch and after school for additional computer time.

I began teaching with laptops during the 1997-98 school year, the second year of the project's implementation. I taught English and social studies to two sixth grade classes of approximately thirty students each. Another teacher, similarly trained and proficient with technology, taught math and science to the same groups of students. Both of us saw the students for two fifty-minute periods a day. As a humanities teacher, I relied mainly on Word, a word processing program, and PowerPoint, a presentation program.

Conceptual Overview: Impact of Laptops on Classroom Life

After the students received their laptops in October, daily life in the classroom began changing in several ways. These changes did not occur all at once: some of them were immediately apparent, but others surfaced more slowly and subtly. Over the course of the entire 1997-98 school year, I observed the following alterations in classroom life.

1) I created new procedures for several aspects of classroom management in order to take advantage of the special capabilities of the laptops.

Classroom management is one of the main concerns of the novice teacher, and it quickly became one of my main concerns as a novice laptop teacher. The laptops demanded a different physical setup of the classroom and a different set of rules and procedures. With appropriate structures in place, however, the laptops helped facilitate the management of individualized instruction.

a) Physical environment

Weinstein (1979) points out the importance of physical setup for classroom management. After the laptops were introduced, I needed to reorder the physical environment to meet certain needs that are basic to the operation of a laptop classroom.

First, students in a laptop classroom need easy access to a power source. Theoretically, students were supposed to charge their laptops at home and operate them on battery power in class. In reality, students weren't always able to charge their batteries at home; and even if they did, the batteries often didn't last long enough to complete all of the class activities. I purchased several power strips, which allowed all students to plug in their laptops at the same time. However, we were still limited by the fact that all of the available plugs were located by one of four wall outlets, and those outlets were not necessarily near the students' desks. One of my colleagues solved this problem by asking her students to move quietly to the nearest outlet if they found their laptops losing power, and so students often ended up sitting on the floor in clusters around the outlets. I found this movement too disruptive, especially during group work when whole groups needed to move, so I bought extension cords long enough that all students could work at their seats. However, my policy meant that extension cords were strewn across the room, increasing the likelihood of students tripping and/or a laptop falling. A more effective laptop setup would require additional outlets, evenly spaced so all students could access them easily. Power strips could be built into the floor, or the desks could be placed against the outer walls of the classroom.

Second, teachers in a laptop classroom should be able to glance quickly around the room and see all of their students' screens. When conducting whole-class lessons, particularly on computer skills, the teacher needs to be able to assess whether or not students are following the lesson. When students are engaged in group work, the teacher needs to conference with small

groups; and this process will be continually interrupted unless the teacher is able to scan the room quickly to ensure that the rest of the students are on task. Since laptop screens are vertical, the need for quick monitoring means that student desks should be facing the same direction. At the time the laptops were introduced in my classroom, I had arranged the desks in a U-shape because this format provided the flexibility for students to move easily between class discussions, small group activities, and individual work. However, I found it very difficult to monitor student work from this setup because I could never see more than half of the computer screens at one time. One of my colleagues attempted to solve this problem by moving her students' desks into rows with the desks pushed together; in this arrangement the students could collaborate with those next to them, and the teacher could see their screens easily. I decided not to change my seating arrangement because I still wanted students to face each other for whole class and small group discussions. When arranging classroom furniture, laptop teachers must consider the special requirements of the laptops along with other instructional needs.

Third, teachers in a laptop classroom need access to a printer. Teachers need a printer not only to disseminate information and assignments to students, but also to print out finished products. Students are motivated to polish their work to a high level of quality if they know that they will receive an attractively printed product at the end. Printing is also a critical part of the editing process. Students can easily revise the content and style of their writing directly on the computer, and they can use the Spelling and Grammar check feature to pick up basic errors. However, students often need more extensive feedback about grammatical conventions, and I could edit grammar mistakes most quickly on a printed copy. For most of the year, I had limited access to a printer, so I only printed finished products. I found that I wasted a great deal of time trying to help my students edit directly on screen. In addition, there could be long delays

between when a student finished a piece of writing and when they received a printed copy, and I found that these delays decreased students' motivation to polish their final products. A laptop classroom will run more effectively if the class has access to a printer, so that students are able to take advantage of the computer's ability to produce professional-looking products.

Fourth, teachers in a laptop classroom also need access to a projection device, for use both as a teaching tool and a means of presenting student work. Because we did not have access to a projection device early in the year, I used charts and handouts to give students step-by-step instructions for initial computer skills. By mid-year, the school received a projection device that would display the contents of a laptop screen on a television screen. Although four teachers had to share this device, we were easily able to arrange our schedules so that each of us could use it when needed. I found that introducing computer skills became much easier when I could simply show the students what to do, rather than describe each action verbally. Just as important, the projection device allowed students to share their multimedia presentations in multimedia format. Simply printing out text could not convey the richness of the sound and movement found in their presentations. Before we received the projection device, if students needed to share presentations, we set up each group's laptop as a viewing station, and students would rotate through the stations. However, the projection device allowed students to present to the entire class, thus providing them with both the opportunity to build their oral communication skills and the opportunity to learn from each other.

b) Procedures

Not only are certain changes in the physical environment necessary for the success of a laptop classroom, but so are changes in classroom routines and procedures. After my students received their laptops, I needed to develop new sets of procedures, focused around the storage,

use, management, and care of the laptops. I also had to develop consequences for inappropriate use of the laptops.

For security reasons, I developed extremely tight procedures for storage of the laptops. At the same time, however, students needed to be able to access their machines quickly and easily, so as not to interrupt the flow of instruction. The district had equipped my classroom with two locking cabinets, in which the computers were stored when not in use. Each student's computer had its own slot in the cabinet, and when the students in my homeroom needed their computers, I directed student monitors to unlock the cabinets. I would call groups of students to get their computers, return to their seats, and boot up. At the end of the activity, I would call groups of students to put away their computers, and the same student monitors would check to see that all computers had been returned to their proper slots before locking the cabinets. It was crucial that all laptops be accounted for, to ensure that no student removed a computer from the building unaccompanied by an adult, and to ensure that we would be able to give accurate information in case of theft or damage. It was also crucial that the cabinets stay locked, since many people had keys to the classroom.

I taught two groups of students, and when the students in the other homeroom needed their computers, I would notify their teacher in advance. The students would bring their laptops to my classroom and store them under their seats or on their desks until we needed them. Even though the laptops crowded students' desk space, we found this approach preferable to disrupting lessons by sending students from one room to another to get their laptops. We taught the students how to carry their laptops safely in the halls by holding the machines close to their bodies and preventing their power cords from dragging on the floor.

In general, I tried to continue established classroom routines, but in some cases, procedures needed to be adapted for use with the laptops. For example, if I needed to make an important point while students were working on a paper and pencil assignment, I would simply ask them to pause and look at me. However, the laptops proved too distracting in this situation, so during laptop activities, I would ask students to save their work and close their screens as well. In another example, students were expected to ask permission to sharpen their pencils, but if their laptops lost power, they could plug in to an outlet without asking, since the computer would shut down if there were a delay.

By contrast, the demands of the laptops did significantly change the management of student assignments. First, I had to ensure that the students and I could find their assignments. As a teacher, I had to specify the name and location for saved assignments, since a computer assignment saved under an unrecognizable name or in the wrong area of the computer is not easily retrieved. Eventually, I had students create desktop folders for each subject. Once I ensured that I could find students' work, I had to develop procedures for feedback and evaluation. Sometimes I collected work on disk, assigning one disk to a group of four or five students. Sometimes I checked work directly on the students' computers, although this meant I needed to finish the task in school. I occasionally gave students feedback on paper, but they were able to focus better on comments incorporated directly into their documents. If I collected the work on disk, I would have to distribute the disks back to the groups, and they would have to copy the revised documents back to their computers. For this reason, I preferred to check work directly on the students' computers, collecting it on disk only for the final printing.

Having laptops in the classroom also necessitated the development of policies for their care. When they first received their laptops, students delighted in the chance to personalize them

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by installing passwords, special backgrounds, and commercial software (primarily games). Passwords caused multiple problems. First, they prevented others from accessing the student's documents. Teachers needed access to these documents in order to monitor appropriate use and evaluate work; if students were working on a group project, they might need to access a peer's documents as well. Second, if a student forgot a system password, the computer would be rendered useless (without prohibitively expensive repairs). Thus, the use of passwords was forbidden. We did allow students to install software, but many of them installed such memory-intensive games that their systems began malfunctioning. Rather than forbid students to install programs, the math and science teacher taught them how to check the system memory and to delete programs when necessary. Students were then able to monitor their own computers.

As in any classroom, I had to set clear policies for student behavior. Some behaviors, such as spending excessive amounts of time changing fonts, backgrounds, and color schemes, merely served to waste class time. I soon learned to minimize these behaviors by giving students more explicit instructions and by setting aside time at the conclusion of a project for them to decorate their work. However, some laptop-related behaviors, such as playing computer games during class time or roughhousing near a computer, were treated more severely. To deal with these infractions, I initially tried revoking the privilege of using the laptop, directing students to work on paper instead. However, this solution quickly proved unsatisfactory because students fell behind in their assignments. I certainly wouldn't have taken away students' pencils and paper if they misbehaved, and taking away their laptops was similarly unhelpful. My colleagues and I settled upon the solution of deleting students' games if they played during class time. If students roughhoused near the computers, we gave them a time-out and dealt with their behaviors individually. The laptops were part of our day-to-day instruction, and these policies

provided teachers with consequences which were appropriate and effective, but which didn't jeopardize students' academic work.

c) Managing individual learning needs

With an appropriate layout and procedures in place, I found that the laptops helped me manage the classroom in a way that accommodated the needs of individual learners. Classroom management research indicates that teachers have difficulty managing mastery learning, where all students are expected to reach success before the class moves on, because students learn at different rates (Arlin, 1982; Arlin & Webster, 1983). In non-laptop classrooms, if most of the students have completed an assignment satisfactorily, the teacher must move on, or face management problems from bored and restless students (Kounin, 1970). The laptops helped keep students engaged in a productive manner, and I was able to assist students who needed additional help. How did the laptops keep students engaged? First, they provided meaningful work for students who had mastered the content of a given assignment. These students could focus on developing sophisticated graphics, sound, and layout for their assignments. Because I believed that such technology skills would be useful to my students in the future, I felt comfortable allowing them to pursue these activities while I assisted other students.

Second, the laptops provided a stimulating learning environment for students with different learning styles. Different programs allow students to incorporate graphics, animation, text, and sound, important for students with visual, kinesthetic, and auditory learning styles. Other programs allow students to manipulate and represent data in multiple forms.

Finally, working with the laptops was often more interactive than working with pencil and paper, and thus students were better able to maintain focus on their work. Gump (1982) found that students paid closer attention during assignments characterized by active input of

stimuli than during assignments characterized by passive availability of materials. In the active structure, students were pulled along through the work (by teacher questioning, for example); in the passive structure, pacing depended on students' understanding of what to do and their motivation to do it (during independent seatwork, for example). The Microsoft Office programs provided students with more active input than pencil and paper. For example, I often assigned students to write letters. With pencil and paper, they would frequently write their heading and sit staring at a blank paper until I walked by and offered a suggestion or an encouraging word. With the laptops, students would open a Word document, type their heading, and a help character (such as a talking paper clip) would appear and ask if they wanted help typing a letter. Students still needed to write the letter, but the program itself provided an active stimulus to continue, freeing my time for more substantive assistance. If students spelled words incorrectly or made grammar mistakes, their errors would be underlined in red or green. Correcting those errors would cause the underline marks to disappear, providing immediate feedback that I would otherwise have needed to provide. Similarly, PowerPoint prompted students to fill out certain text fields and add certain effects. When students viewed their shows, it became immediately apparent when information was missing, again freeing my time to deal with more substantive issues.

2) Students began to collaborate spontaneously, because of an authentic desire to share information about different features of the software and the computers themselves.

Research suggests that students will collaborate willingly and effectively if they have a mutual need for each other's help (Johnson, D., & Johnson, R., 1984). Although I had always encouraged small group work and student collaboration, the laptops introduced a heightened element of mutual need. As students sought to master the workings of their machines and the

complexities of the Office applications, authentic reasons to collaborate were frequent. Students entered the program with different levels of prior knowledge about computers; and their experimentation, at home and at school, gave them different areas of knowledge and expertise. Students shared materials, such as software, CD-ROMs, and images downloaded from the Internet, as well as their knowledge of how to utilize these materials. They also delighted in sharing their knowledge of different special effects, especially in PowerPoint.

The increase in collaboration extended to the students' relationship with me as well. The laptops changed the authority relationship in the classroom, so that my students and I became more equal partners in the learning process. In my previous teaching, I had sought to value students' prior knowledge and personal contributions, but the fact remained that I was still the curriculum and content area expert. In the laptop classroom, although I certainly continued to be a valued resource, I wasn't the only (or even the most expert) source of knowledge. My students could and did show me new techniques; and if students asked me how to do something, I frequently had to refer them to their peers. I didn't abandon responsibility for student learning, but I became more likely to facilitate the exchange of information among students than to provide the information directly. In addition, because of the overall challenges of managing this new classroom environment, I simply had to delegate several important tasks to my students. For instance, students from another class taught a pair of my students how to operate the projection device. These students taught others, but I never had time to sit down with them and learn to use it. During the entire year, operating the projection device remained a student responsibility.

3) Students were able to organize and revise their work with greater ease.

The capabilities of the Office programs helped students become more effective with different aspects of the writing process. Many sixth graders still think primarily in concrete terms (Crain, 1992; Elkind, 1994), but the writing process requires them to organize, revise, and evaluate their work in ways that are often quite abstract. The different features of Word and PowerPoint helped make these activities more concrete, and thus increased students' understanding of the underlying concepts.

I found the programs particularly useful in teaching students how to organize their work. In Word, students could create outlines or use text boxes to make graphic organizers. I found PowerPoint even more helpful in teaching organization; for research projects, students would create a different slide for each topic, and when time came to write the report, they would turn each slide into a paragraph. Students learned the concrete action of moving facts about one topic to a particular slide or text box, and they were able to equate this concrete action with the more abstract idea of explaining one topic in a particular paragraph or section of a report.

The laptops also helped make the revision process both easier and more concrete. An important aspect of revision is the large-scale revision of content – moving or adding chunks of text. Word processing programs facilitate such revision because students can easily perform these functions within the program, rather than recopying an entire piece by hand. For example, in a lesson on writing action scenes, I had students read each other's stories and use the highlighter function to indicate the climactic moment. After discussing different ways to build dramatic tension, I asked students to place their cursor at the climactic moment of their piece and use our strategies to heighten the excitement. Such a concrete process made it easier for students to understand how and why to revise, without requiring tedious recopying.

Another important aspect of revision is giving and incorporating feedback into a piece of writing. The laptops offered a variety of ways to make this process easier and more concrete. The Comment feature allowed reviewers to incorporate feedback directly into a piece. Students could also make changes to each other's writing and save the changes under a different name, so the original author could choose whether to accept or reject those changes.

Before publishing a final product, students' written work needed to be edited. I taught students how to use the Spelling and Grammar Check function, choosing the most appropriate word for their particular needs, rather than blindly making all suggested changes. A colleague had students use the Find/Change command to find homonyms and evaluate whether they had used the appropriate spellings. I even used different functions of the laptop for grammar mini-lessons. For instance, I had students use color to categorize parts of speech and the Cut/Paste commands to match subjects and predicates. However, while the laptops helped students take greater control over the editing process, they still needed the teacher's input for final edits.

Once a final product was complete, the piece was ready for publication. Not only did the laptops allow us to print professional-looking final copies, but students also learned to use PowerPoint to present their work.

4) I placed a greater emphasis on research skills and the critical evaluation of information.

The laptops prompted me to develop a curriculum that was increasingly research-oriented. Many teachers report that having laptops in the classroom causes them to increase their use of project-based instruction (Rockman, 1998). I already used projects extensively in my classroom, but the nature of the projects changed. In previous years, most of my projects focused on literature and creative writing, but after the introduction of the laptops, I began assigning more research projects.

I believe the reason for this change lay in the nature of the tools accessible to me – the laptops themselves and the Microsoft Office programs. The laptops themselves provided access to multiple sources of information. We could easily introduce informational CD-ROMs and educational software. Although we didn't have Internet access at school, having the laptops at home meant that teachers could download information from the Internet and distribute it to students. We didn't even need to print the information: we could simply copy it onto several disks and distribute it electronically. The Microsoft Office programs, particularly PowerPoint, provided an easy and effective way to organize the research projects.

The laptops also caused me to emphasize the critical evaluation of information. Even though our school did not have Internet access, my students would eventually have access to thousands of information sources, and I knew they would need the skills to sift through that information and evaluate its usefulness and accuracy. I wanted students to begin learning these processes on pencil and paper, so I began to emphasize the use of multiple sources of printed information in my lessons.

5) I assigned student presentation projects with greater frequency.

Not only did I change the content of the projects I assigned, but I also changed the method of expression. In the past, I had relied heavily on art, drama, and stories as modes of expression, but because of our access to PowerPoint presentation software, I began to emphasize oral presentation projects. In the past, I had found student presentations difficult to orchestrate and manage. Classroom management research from traditional classrooms demonstrates that student involvement is lowest and students find it hardest to concentrate during prolonged student presentations (Gump, 1967; Mayers, Csikszentmihalyi, & Larson, 1978). In general, teachers have a heightened awareness of how to present information – clearly delineating topics,

projecting their voices clearly, and so forth; so it seems logical that students would find it easier to attend to teachers than to their peers. However, PowerPoint was created to help adults present ideas clearly and memorably, and I found it a useful tool to develop these skills in students as well.

First, Power Point helped students organize their information. As mentioned before, they learned to separate different kinds of information on different slides. In order to create slides, students learned to summarize their main ideas in bullet points; and in their oral presentations and written reports, they learned to expand on these main ideas by including supporting details and explanations. Second, students learned to represent their ideas with graphics, sound, and animation. Finally, after viewing and making several presentations, students began to develop solid public speaking skills.

I used presentations for different purposes. At first, I concentrated mainly on developing students' sense of what constituted an effective presentation. Students viewed each other's presentations and evaluated them based upon a set of criteria. Then I shared the results of the peer evaluations with each group. Later, I began to use presentations as a mechanism for students to practice note-taking strategies and to learn from each other. While one group presented, the rest of the students would take notes. Then the class would discuss the information that they had learned and any information that was unclear.

In my previous teaching, I had used drama, art and stories, but never informational presentations. However, with the ready availability of a tool that helped me meet important academic objectives and develop public speaking skills, I incorporated presentations into a variety of curriculum projects.

Case Study

The preceding section points out changes that occurred with the introduction of laptops into an ordinary sixth grade classroom. However, the changes described are general trends that occurred across a variety of subjects and activities over the course of the entire school year. These changes can be studied in more detail by examining a specific case, a unit on ancient Egypt that I taught in both laptop and non-laptop settings.

The study of ancient cultures is an important part of the sixth grade social studies curriculum, and for the past few years, I have led my students in an intensive study of ancient Egypt. During the 1995-96 school year and again during the 1997-98 school year, my students explored daily life in ancient Egypt through a project that I called "Create-a-Character." The first group of students did not have access to any computer technology, while the second group had constant access to their laptops; the addition of these new tools changed the implementation of the project in ways consistent with my overall experience with technology and with current research on technology integration.

Description of Project

The "Create-a-Character" project required students to work in groups to create a character from ancient Egypt. Students selected an Egyptian name for their character and wrote a description of that character's looks and personality. Students were assigned to a social group, an important determinant of lifestyle in ancient Egypt, and then they researched different aspects of their character's daily life, such as food, clothing, and work, from the perspective of the character's social group. The project culminated in the writing and presentation of the character's biography.

The final projects differed slightly in the laptop and non-laptop classrooms. In the non-laptop classroom, the members of each group wrote their character's biography as a collaborative creative writing project. Then one member of the group dressed as the character and presented his or her "life" to the class. Each group also built and presented a model of the character's home.

In the laptop classroom, students made PowerPoint presentations describing their character's life. I also gave a written test in which students wrote their character's biographies using the information contained in their PowerPoint slides.

Management

During both years of implementation, students worked in small groups. In the non-laptop classroom, students worked in groups of four, while in the laptop classroom, they worked in pairs. No more than two students could work effectively on one laptop because the small screen size made it difficult for a larger number of students to see the work.

I managed student notes in the same way in both settings. Students kept their notes in a research folder, and I checked folders nearly every day and assigned points for the notes. Students could include as many details as they wanted, but missing central information would result in a deduction of points. They were encouraged to go back and find the missing information to increase their point total. This system was effective because it helped students keep track of their work, and it helped me, as the teacher, ensure that students were acquiring a solid foundation of information on which to base their projects.

However, one problem in the first implementation of the project was the fact that students did not engage in activities that required them to process and use their notes immediately. By the

final stages of the project, students' initial notes had been sitting in the folder for weeks, and they had forgotten what they learned.

PowerPoint slides provided me with an effective way to help my students process and organize their information immediately. I gave students the last fifteen minutes of every class period to create a slide summarizing the most important points they had learned about the day's topic. Not only did this process help students engage with and remember the information, but it also helped develop their organizational skills. Because each topic received its own slide, students were reminded of the importance of categorizing information by topic. Because the bullet points had to contain the most important kernels of information, students learned to prioritize information. Because slides contain limited space, students were forced to restate information simply and succinctly, to "use their own words" in classroom parlance.

I deliberately limited the time I gave students to create these slides because past experience had taught me that they would simply use extra time for animation and visual effects. I made it clear at the outset that this time was for typing only, and that I would give them class time at the end of the project to add visual and sound effects.

Collaboration

In both implementations of this project, students had to work together with fellow group members. Because working in groups is a complex process, and there are differences in student effort and learning, I required that all group members take an active role in the acquisition of information: students would take turns reading and taking notes. Switching tasks did ensure that students shared the work, but it did not ensure that they understood the material. However, because students needed to create a slide by choosing information from an average of two to three pages of handwritten notes, I frequently observed them passing their notes back and forth,

explaining sections to each other, and arguing over the best information. Working together to create the slide required students to collaborate in analysis, not simply information-gathering.

I was also concerned that all students be actively involved in the writing of the character biography. In the non-laptop class, I found that one or two students essentially wrote the story for the group. With the laptop students, I incorporated many of the elements of the biography into the PowerPoint slides. I found that nearly all of the students stayed engaged during the creation of the slides, so they all had a hand in the creation of the character's life story. When individual students then wrote the character's biography on their test, I was able to see similarities in the historical details included by members of the same group, an indication that they had collaborated to attain the same information base.

In addition to collaboration within groups, laptop students shared information across groups in a way that non-laptop students did not. They shared the informational CD-ROMs available, some of which belonged to the school, but others of which belonged to individual students. Certain members of the class knew how to incorporate QuickTime video into their presentations, and I observed those students teaching members of other groups. When using this activity with non-laptop students, the only inter-group sharing I observed was when one group shared paint with another group, a practice that soon stopped when supplies ran low.

The Writing Process: Organization, Feedback, and Revision

In both implementations of this project, I felt reasonably satisfied with the information-gathering process. The "Create-a-Character" project was part of a larger effort to help my students develop effective note-taking strategies. When I reviewed student notes, I would comment on both note-taking strategies and the information itself. Because suggested changes

were small and manageable, students were generally motivated to add to their notes in order to get the full allotment of points for that section.

However, after the first implementation of this project, I was concerned about students' organization and revision strategies. The character biographies lacked historical detail, and the presentations were amusing, but not particularly informative. My students needed greater assistance in the writing process, particularly since the biographies were essentially a form of historical fiction, a genre few students write regularly or proficiently. My students needed effective pre-writing strategies that would facilitate the incorporation of historical details into their stories. I also needed to provide more structured opportunities for revision and review.

The laptops helped me provide students with more support in creating the biographies. The PowerPoint slides served as pre-writing organizers. I stressed that slides should focus on the topic as it related to their individual character. If the character were a farmer, the slide about food should describe the food that a farmer might have eaten, not Egyptian food in general.

Remembering the past group's difficulties, I was committed to helping my students revise their slides as an ongoing part of the project, not simply as a final step. Two methods were used to encourage revision. With one group of students, I viewed their slides and provided feedback on large index cards. With the other group of students, I used the Comment feature of PowerPoint to incorporate my feedback directly into the slides. Not surprisingly, I found that students were much more likely to utilize feedback provided directly into the slide.

Overall, the laptop students' essays contained considerably more historical details. More specifically, the number of historical details was counted in five essays randomly selected from the work of each class. The non-laptop students' essays contained an average of 7 historical details per essay, while the laptop students' essays contained an average of 17. Using

PowerPoint to organize and provide feedback on students' historical information helped them incorporate relevant details into their writing.

However, my emphasis on including historical information resulted in a change in students' creative expression. With the non-laptop students, I had spent much of the year focusing on creative writing; with the laptop students, I had spent much of the year focused on researching, organizing, and presenting information. These instructional priorities are clearly evident in the opening paragraphs of the character biographies.

Carlos,* a student from the non-laptop group, opens his narrative with fairly sophisticated attempts to use both dialogue and a time lapse. He opens with action in order to interest the reader, but then moves immediately to the next action point of his story, which occurs in Zoser's adulthood.

> "WAAAA!" cried Zoser.
> He was just one week old. His mother, Isis got very sick while she was in labor. Her husband, Othirus [sic] was very angry at the doctors cause the doctors didn't tell him anything.
> "Is Isis and Zoser alright?" said Othirus.
> "Yes. Indeed" said Dr. Ramses.
> "The only problem is that Zoser only weighs 8 _ pounds."
> "But is he alright? Is he sick or something?" said Othirus.
> "Of course not" said Ramses.
>
> 10 years later.....
>
> "I'm King Zoser and you do what I say or you will be executed" said King Zoser.
> He was the new king and he had a lot of problems with Seti, his cousin. Seti [cheated] with Zoser's wife Cleopatra.
> Now Seti excaped and Zoser send guards looking for him. they made him kill a bear when he finished he had bruises and cuts. Then after that King Zoser beat him up and threw him in the Nile...

Carlos goes on to describe Seti's magical return to life with the help of his friend Thutmose, and their epic battles with Zoser. Contrast this narrative with the opening to Josefina's story.

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* Students' actual names have been changed.

> Cleopatra was born on a big block with two legs. She was born on the air and then fell straight on the floor and maybe bumped her head when she fell.
>
> When she was young she couldn't go to school only her brother. No women could go to school only the men. She was so young that when it was very hot she never hade to wear any clothes. She played many games most of them were all made of mud. Her dolls were mostly only a head cause the legs and arms were all stuk together and then drawn.
>
> Cleopatra got married when she was 12 years old with a 14 year old boy named after his grandfather Zoser. Her sister had married her uncle Khufu.
>
> Cleopatra was very happily married. Then she had a girl and a boy. Of course the boy was named after his grandfather like all the older boy born first. Then one day she decided to get a divorce. When she did all of her kids stayed with her.
>
> Cleopatra had to work very hard now that she was all alone and she lost a lot of money since getting divorce cost so much. But she wasn't the only one her daughter had to help her in everything. Because she was a hard working farmer…

Josefina displays none of Carlos' lively style, but in roughly the same amount of space, her writing contains accurate historical details on Egyptian birthing chairs, education, dress, children's games, marriage and divorce customs, and naming conventions. In the laptop classroom, the entire project focused around the acquisition, organization, and presentation of information. Students displayed significant creativity in using graphics, sound, and animation to enhance their PowerPoint presentations, but they were given little opportunity to develop artistic, musical, or dramatic talents as they had in previous years. Rockman (1997) reports that teachers in laptop classrooms typically experience a period in which they neglect previous teaching methods in favor of the laptops, but that they eventually find a more balanced approach. In future implementations of this project, I would strive to balance the development of information-related skills with the development of artistic forms of expression.

Research skills and critical evaluation of information

Because the "Create-a-Character" project required students to gather information more detailed than that provided in the textbook, I was faced with the difficulty of helping my students find this information. In the non-laptop classroom, I solved the problem by purchasing a few informational children's books about ancient Egypt and xeroxing information packets on each

topic. Because of the expense and logistical difficulties involved in reproducing packets for each group of students, I generally limited the information to two articles on each topic.

In the laptop classroom, I approached the issue of acquiring information quite differently. Because we didn't have Internet access, I still relied on children's books, but I was also acutely conscious of the fact that my students would be expected to use the Internet effectively the following year. I wanted to help them acquire the skills necessary to evaluate, manage, and process the vast quantities of information available on the Internet. For that reason, I invested in several more children's books on Egyptian culture, enough for each group to have one. I wanted my students to deal effectively with multiple print sources as preparation for dealing with multiple electronic sources.

With the non-laptop students, the focus of note-taking was simply to summarize the information in the selection. Because I had provided more information sources for the laptop students, the focus of note-taking changed. Students would take down only the information relevant to their topic, and as soon as they finished, they could trade books with another group and look for different information. Although I still insisted that students include in their notes information that I considered important, their presentations and final exams clearly showed that they had absorbed a great deal of additional information that *they* considered important, such as breast-feeding habits, or average age at death. I believe that the freedom to peruse different sources of information helped my students learn far more about ancient Egypt than they would have otherwise. Indeed, I was shocked to hear a student referring to the hierarchical pyramid of Egyptian society, something I hadn't taught that year. When I asked her where she had learned about it, she nonchalantly responded, "Oh, I just kept seeing it in all the books."

Presentations

The importance of the PowerPoint presentation in shaping this project is consistent with observations, both my own and those of Rockman (1997, 1998) about teachers' increased use of student presentations in laptop classrooms. Although I included character presentations in the first version of this project, presentations were not a regular feature in my classroom, and I did not include instruction on effective presentation styles. Consequently, students' presentations were not well organized or supported by historical details. Students who were naturally gregarious performed well in front of their classmates, but other students whispered, giggled, or lost their train of thought.

By contrast, the laptop-based presentations were part of a yearlong effort to help students develop their oral presentation skills. Early in the year, students learned five basic criteria for a successful presentation: information, organization, visual effects, sound effects, and oral communication. Students frequently had the chance to evaluate each other's presentations on the basis of these criteria, and we had discussed what made a presentation effective or ineffective. Consequently, students were able to present their information in a manner that was organized, clear, and generally easy to follow.

Conclusions

The purpose of this study was to examine the changes in classroom practice that occurred with the introduction of laptop computers for every student. How did the laptops, as educational tools, change the daily work of the classroom? Why did these changes occur, and how did the specific features of the laptops and the software shape the nature of the changes?

First, the laptops changed the management of the classroom. On a very basic level, their introduction necessitated a new physical setup and new routines and procedures. My experience

with classroom management was consistent with the literature on technology integration, in that I found students more engaged during laptop activities (McDonald & Ingvarson, 1997; McMillan & Honey, 1993; Means, 1995; Rockman, 1997; Rockman, 1998; Schofield, 1995). Other research has suggested that the visual, auditory, and kinesthetic stimulus provided by the computer interface may appeal to students with different learning styles (Means, 1995; Rockman, 1997), and that students may also enjoy the immediacy of feedback and feeling of personal control involved with manipulating the computer environment (Means, 1995; Schofield, 1995). In my classroom, I found that the commands and options on the laptop imparted to student assignments a more "active structure" (Gump, 1982) than pencil and paper assignments, and this structure helped students stay focused. I also found that students who completed the content of their assignments before their peers were able to practice technology-related skills by enhancing the appearance of their work.

The fact that my students were highly and productively engaged during laptop activities encouraged a facilitative instructional style in which I, as the teacher, could move among students or groups of students, offering individualized assistance. The laptops helped me better assist individual groups because the other students were engaged in appropriate and meaningful activities. The laptops also changed my relationship with my students. Because they could often teach me information about the computers, we became more equal partners in the learning process. A similar process happened between students; because they wanted to share and learn new techniques from each other, they began to collaborate for authentic reasons.

Finally, the laptops caused me to emphasize different types of academic tasks. The computers themselves afforded students easier access to research materials, such as informational CD-ROMs and educational software. The Microsoft Office programs allowed

students to organize and present this information effectively. Thus, I changed my curriculum to emphasize research and the critical evaluation of sources, and I altered many project assignments to incorporate PowerPoint presentations.

In conclusion, this study suggests that laptops change instruction in characteristic ways. Certain kinds of work became easier to manage, and thus were assigned more frequently. As a teacher, having continuous access to the laptop caused me to change and redefine the focus of classroom activities.

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